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Soybean Sudden Death Syndrome Influenced by Macronutrient Fertility on Irrigated Soybean in a Corn/Soybean Rotation

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Abstract

The effects of nitrogen (N), phosphorus (P), and potassium (K) fertilization on a corn/ soybean cropping sequence were evaluated from 1983 to 2014, with corn planted in odd years. We observed a relationship between the P rate applied during the corn years and the severity of sudden death syndrome (SDS) in 2014 soybean.

Keywords

soybean sudden death syndrome, soybean sudden death syndrome severity, irrigated soybean, macronutrient fertility, soybean yield, Kansas River Valley Experiment Field

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E.A. Adee and D. Ruiz Diaz

Summary

The effects of nitrogen (N), phosphorus (P), and potassium (K) fertilization on a corn/soybean cropping sequence were evaluated from 1983 to 2014, with corn planted in odd years. We observed a relationship between the P rate applied during the corn years and the severity of sudden death syndrome (SDS) in 2014 soybean.

Introduction

A study was initiated in 1972 at the Topeka Unit of the Kansas River Valley Experiment Field to evaluate the effects of N, P, and K on furrow-irrigated soybean. In 1983, the study was changed to a corn/soybean rotation with corn planted and fertilizer treatments applied in odd years. Study objectives were to evaluate the effects of N, P, and K applications on a corn crop on grain yield of corn, yield of the following soybean crop, and soil test values.

Procedures

The initial soil test in March 1972 on this silt loam soil was 47 lb/a available P and 312 lb/a exchangeable K in the top 6 in. of the soil profile. Rates of P were 50 and 100 lb/a P_2O_5 (1972–1975) and 30 and 60 lb/a P_2O_5 (1976–2011), except in 1997 and 1998, when a starter of 120 lb/a of 10-34-0 (12 lb/a N + 41 lb/a P_2O_5) was applied to all plots of corn and soybean. Rates of K were 100 lb/a K_2O (1972–1975), 60 lb/a K_2O (1976–1995), and 150 lb/a K_2O (1997–2011). Nitrogen rates included a factorial arrangement of 0, 40, and 160 lb/a of preplant N (with single treatments of 80 and 240 lb/a N). The 40 lb/a N rate was changed to 120 lb/a N in 1997. Treatments of N, P, and K were applied every year to continuous soybean (1972–1982) and every other year (odd years) to corn (1983–1995, 1999–2013). Soil cores were pulled from each plot in the spring of 2014, prior to planting. Analyses for macronutrients were performed from soil for each 1-ft increment to a depth of 4 ft.

Soybean varieties planted in even years were: Douglas (1984), Sherman (1986, 1988, 1990, 1992, 1996, 1998), Edison (1994), IA 3010 (2000), Garst 399RR (2002), Stine 3982-4 (2004), Stine 4302-4 (2006), Midland 9A385 (2008), Asgrow 4005 (2010), As-

grow 3832 (2012), and Asgrow 3833 (2014). Soybean was planted in early to mid-May. Herbicides were applied preplant each year, and postemergent herbicides were applied as needed. Plots were cultivated, furrowed, and furrow-irrigated through 2001 and sprinkler-irrigated with a linear move irrigation system from 2002 to 2014. Percentage of leaf area infested by SDS was rated visually, and normalized difference vegetation index (NDVI) ratings were measured with a GreenSeeker meter (Trimble Navigation, Ag Division, Westminster, CO) on August 28 at growth stage R6. A plot combine was used to harvest grain.

Results

The severity of foliar SDS symptoms in soybean were related to the rate of P applied to the corn in the corn/soybean rotation for the previous years (Table 1). The SDS was most severe, and the NDVI (measure of greenness), heights, and yields decreased as the rate of P decreased. The level of P in the soil was different at the different rates in a soil sample taken in the spring of 2014 (Table 2). The largest difference between P rates was in samples collected from the top foot of soil. There was no effect of N, K, nor any interactions of the three macronutrients with these four measurements (data not shown).

SDS had not been observed to this degree in these plots in previous years. In addition, the effect of P on yield has not been this great, with average yield response for 1984 to 2012 from the check to the 60 lb rate less than 6 bu/a. The development of SDS was probably related to the above-average rainfall in June of 8.26 in., which is 3.62 in. more than the 30-year average.

The negative correlation between foliar symptoms of SDS and NDVI was very strong (-0.82, <0.0001; Figure 1). The NDVI measurements are an objective measurement based on near-infared light reflectance off the crop canopy, which can be affected by the greenness of leaves and density of the canopy, both of which can be influenced by multiple factors. Height of plants, development of branches, number and size of leaves, and amount of chlorophyll in leaves are some of the factors that can affect NDVI readings. The visual ratings of foliar symptoms tend to be more subjective but can focus on a single aspect of crop health, in this case foliar symptoms of SDS. The strength of this correlation indicates that SDS was a primary factor affecting the health of this crop, even though height differences were related to P rates.

Yield of soybean correlated well with both the visual rating for SDS (-0.74, <0.0001) and NDVI (0.83, <0.0001) (Figures 2 and 3). This result suggests that SDS was a major factor affecting yield of soybean in this study. Combined with the strong relationship between the rate of P applied during the corn year of the rotation with yield and NDVI, the negative relationship with foliar symptoms of SDS indicates that P had a significant role in the severity of SDS and subsequent yield loss. To our knowledge, this relationship between P applied as a fertilizer and SDS has not been previously reported.

Table 1. Effects of phosphorus (P) applied to corn on sudden death syndrome (SDS) and yield of soybean, Kansas River Valley Experiment Field, 2014

P rate on corn	SDS severity	NDVI[1]	Height	Yield
lb/a	% foliage affected		in.	bu/a
0	58	0.758	29.8	34.0
30	43	0.777	36.0	44.8
60	23	0.799	37.0	52.9
LSD (0.05)	16	0.018	2.2	4.3

[1] Normalized difference vegetation index.

Table 2. Soil test values for phosphorus (P) in macro-fertility study, Kansas River Valley Experiment Field, 2014

P rate	1st ft	2nd ft	3rd ft	4th ft
lb/a				
0	13	15	22	16.6
30	30	17.4	24.2	17.2
60	92	27.2	30.6	18.4
LSD (0.05)	8.8	1.9	2.7	NS[1]

[1] Not significant.

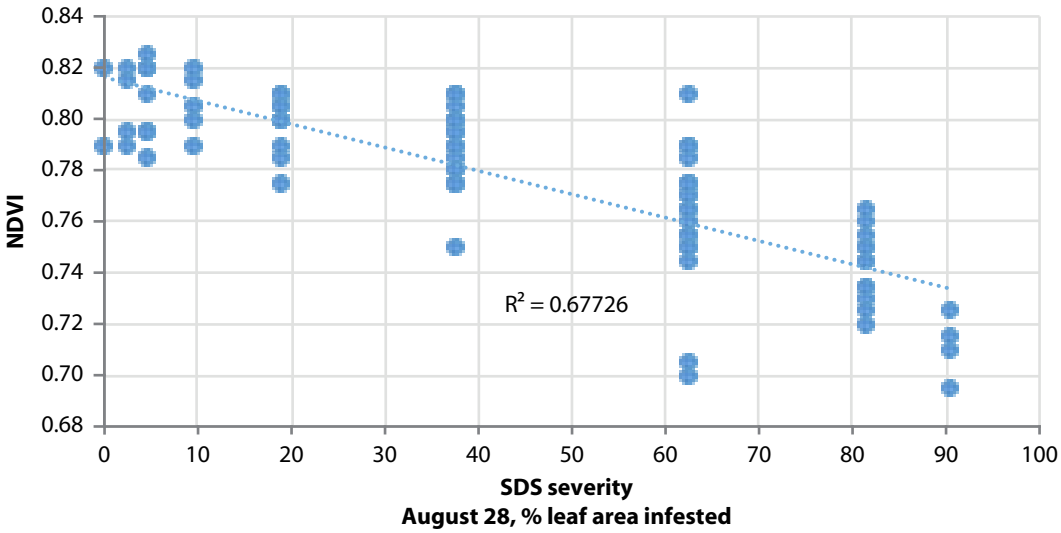

Figure 1. Relationship between visual ratings for severity of foliar symptoms of sudden death syndrome (SDS) and normalized difference vegetation index (NDVI) measurements with a GreenSeeker meter (Trimble Navigation, Ag Division, Westminster, CO) in a long-term macronutrient fertility study at the Kansas River Valley Experiment Field, 2014.

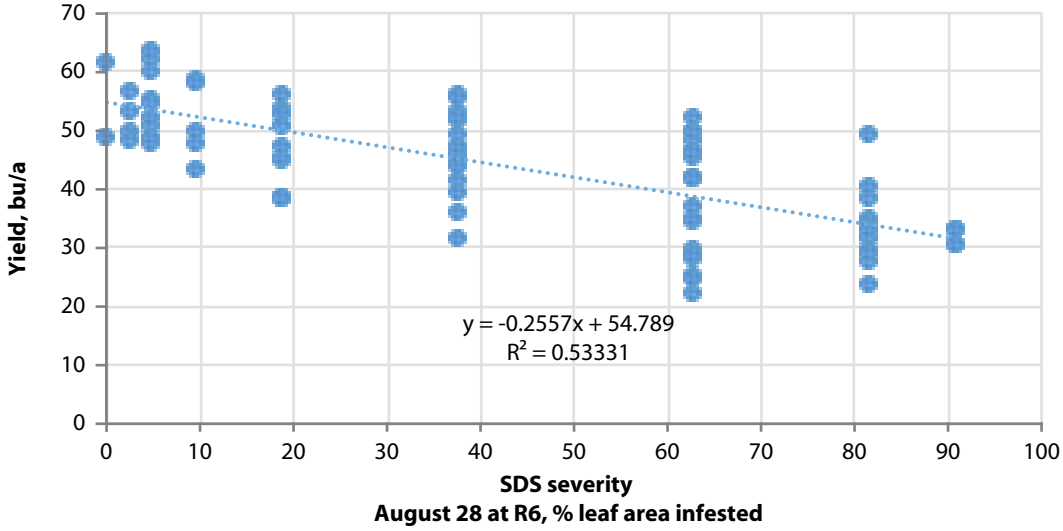

Figure 2. Relationship between foliar symptoms of sudden death syndrome (SDS) and yield of soybean at the Kansas River Valley Experiment Field, 2014.

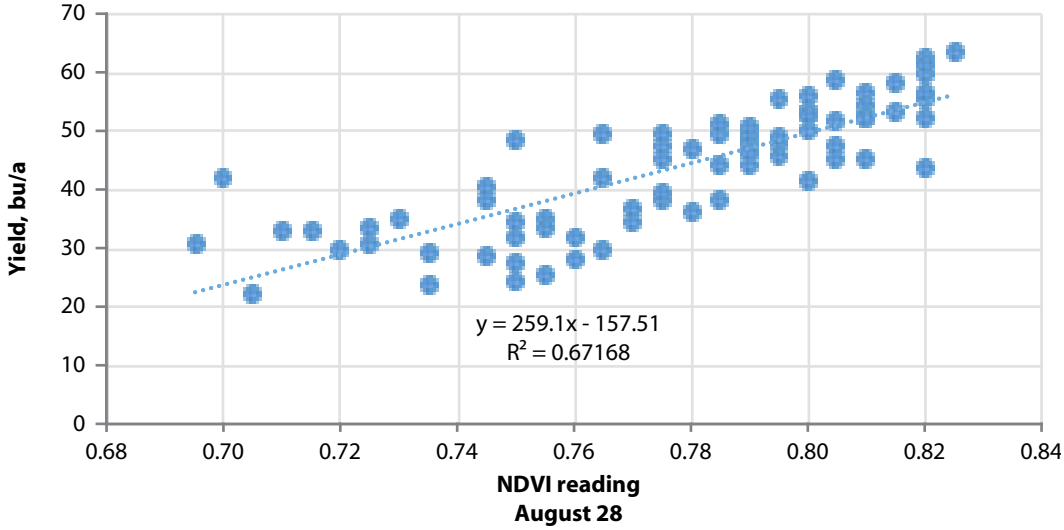

Figure 3. Relationship between normalized difference vegetation index (NDVI) and yield of soybean at the Kansas River Valley Experiment Field, 2014.